CLAIMS

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1. A method for using future behavior of a battery of probes to forecast and diagnose network performance, comprising the steps of:

consolidating normal network data and data returned from a battery of *EPP* probes into a single model matrix, a probe data set in said returned data including at least a time of said probe and a user performance measure;

predicting a future value of said user performance measure from predictor variables in said single model matrix, values of said predictor variables being lagged from said probe time by a prediction horizon;

generating an alarm signal if said predicted future value of the performance measure is above a threshold value;

observing an actual value of said performance measure at the predicted time, said alarm signal being FALSE if the actual value is below a lower alarm threshold and an alarm signal being MISSED if no alarm signal was generated and the actual value is above an upper alarm threshold; and

setting by trial and error said threshold value and said prediction horizon to achieve a rate of said false alarms below a specified limit.

2. The method of claim 1, wherein said predicting step further comprises the steps of:

reducing a dimensionality of said single model matrix by performing stepwise linear regression, at each step adding a most significant network node and deleting a least significant network node, a standard F test providing a significance statistic, until no addition or deletion is significant;

fitting functions of said predictor variables to an additive model; and

generating from said additive model an estimated mean of said future value of said user performance measure of said EPP probe, an estimated variance of said estimated mean, and for each predictor variable an estimated variance of an estimated contribution to said future value of said predictor variable.

3. The method of claim 1, further comprising the step of deriving a control scheme for said EPP probe by selecting coefficients for a formula for said alarm threshold, said alarm threshold formula including a constant term, a seasonality term and a term containing an estimated standard deviation of said future value of said user performance measure, wherein a rate of said missed alarms in said trial and error setting step is determined to be acceptable.

4. The method of claim 1, wherein said model matrix includes for each EPP probe

said user performance measure is a response time Y;

said time of said probe is a time t when said response time Y was observed;

said prediction horizon has a value h; and

wherein for each of said predictor variables said lagged value is taken at, or most recently prior to, time $t - h$.

5. The method of claim 1, further comprising the steps of:

obtaining a list of models, one for each said linear regression step, a model for a last step providing a selected subset of predictor variables;

using a partial stepwise additive procedure to further reduce said dimensionality, said dimensionality being the number of a plurality of said network nodes; and

determining a scale of EPP probe values, said scale being ordered by predictive power.

6. The method of claim 1, further comprising the step of determining interaction terms for said additive model, said interaction terms being a function of more than one predictor variable.

7. The method of claim 3, wherein said step of deriving a control scheme uses profile curves, said profile curves reflecting expected values of said user performance measure based on normally observed regularities in variation of values of said user performance measure.

8. The method of claim 7, wherein said normally observed regularities include variations in a weekly cycle and variations in a daily cycle.

9. The method of claim 1, further comprising the step of presenting a graphical summary of unfavorable predictors in response to triggering of said alarm threshold.

10. The method of claim 2, further comprising the steps of

determining whether said additive model is adequate and triggering a model alarm if said additive model is determined not to be adequate; and

identifying elements of said additive model whose characteristics triggered said model alarm, said identifying step being initiated by said model alarm.

11. The method of claim 10, further comprising the steps of:

selecting a new predictive model from a battery of recovery models; and

building said new predictive model over time as data is accumulated for said predictor variables.

12. The method of claim 1, wherein a predictive model is developed for a plurality of prediction horizons, one model at a time.

13. A system for using future behavior of a battery of probes to forecast and diagnose network performance, comprising:

a single model matrix comprising normal network data and responses to a battery of probes;

profile curves corresponding to said battery, said profile curves reflecting expected response times based on recent history of said probes;

an additive model that predicts the behavior of a function of said probes at a future time, said function being defined in terms of predictor variables in said model matrix, said function being selected by advanced statistical methods, and said additive model being applied cyclically to reduce a variable space of said predictor variables in said single model matrix;

alarm thresholds based on deviation between said profile curves and behavior predicted by said additive model, said alarm thresholds being selected to assure a predictably low rate of false alarms; and

a graphical summary of unfavorable predictors in response to triggering of said alarm threshold.

14. A system as in claim 13, further comprising:

a monitor for determining whether said additive model is adequate, said monitor triggering a model alarm if said additive model is determined not to be adequate; and

a diagnostic for identifying elements of said additive model whose characteristics triggered said model alarm, said diagnostic being initiated by said model alarm.

15. A system as in claim 13, wherein said cyclic application of said model uses an F statistic to control addition and deletion of variables in said variable space.

16. A system as in claim 13, wherein said cyclic application of said model uses a subset of variables determined by a stepwise linear regression (SLR).

17. A computer implemented system for using future behavior of a battery of probes to forecast and diagnose network performance, comprising:

computer code for consolidating normal network data and data returned from a battery of *EPP* probes into a single model matrix, a probe data set in said returned data including at least a time of said probe and a user performance measure;

computer code for predicting a future value of said user performance measure from predictor variables in said single model matrix, values of said predictor variables being lagged from said probe time by a prediction horizon;

computer code for generating an alarm signal if said predicted future value of the performance measure is above a threshold value;

computer code for observing an actual value of said performance measure at the predicted time, said alarm signal being FALSE if the actual value is below a lower alarm threshold and an alarm signal being MISSED if

no alarm signal was generated and the actual value is above an upper alarm threshold; and

computer code for setting by trial and error said threshold value and said prediction horizon to achieve a rate of said false alarms below a specified limit.

18. The computer implemented system of claim 17, wherein said computer code for predicting further comprises:

computer code for reducing a dimensionality of said single model matrix by performing stepwise linear regression, at each step adding a most significant network node and deleting a least significant network node, a standard F test providing a significance statistic, until no addition or deletion is significant;

computer code for fitting functions of said predictor variables to an additive model; and

computer code for generating from said additive model an estimated mean of said future value of said user performance measure of said EPP probe, an estimated variance of said estimated mean, and for each predictor variable an estimated variance of an estimated contribution to said future value of said predictor variable.

19. The computer implemented system of claim 17, further comprising computer code for deriving a control scheme for said EPP probe by selecting coefficients for a formula for said alarm threshold, said alarm threshold formula including a constant term, a seasonality term and a term containing an estimated standard deviation of said future value of said user performance measure, wherein a rate of said missed alarms in said trial and error setting step is determined to be acceptable.

20. The computer implemented system of claim 18, further comprising:

computer code for determining whether said additive model is adequate and for triggering a model alarm if said additive model is determined not to be adequate; and

computer code for identifying elements of said additive model whose characteristics triggered said model alarm, said identifying step being initiated by said model alarm.